

CLEANING OF VISCOUS DROPS ON A FLAT INCLINED SURFACE USING GRAVITY-DRIVEN FILM FLOWS

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ABSTRACT

We investigate the fluid mechanics of cleaning viscous drops attached to a flat inclined surface using thin gravity-driven film flows. We focus on the case where the drop cannot be detached from the surface by the mechanical forces exerted by the cleaning fluid on the drop surface. The fluid in the drop dissolves into the cleaning film flow, which then transports it away. To assess the impact of the drop on the velocity of the cleaning fluid, we have developed a novel experimental technique based on particle image velocimetry. We show the velocity distribution at the film surface in the situations both where the film is flowing over a smooth surface, and where it is perturbed by a solid obstacle representing a very viscous drop. We find that at intermediate Reynolds number the acceleration of the starting film is overestimated by a plane model using lubrication approximation. In the perturbed case, the streamwise velocity is strongly affected by the presence of the obstacle. The upstream propagation of the disturbance is limited, but the disturbance extends downstream for distances larger than 10 obstacle diameters. Laterally, we observe small disturbances in both the streamwise and lateral velocity, owing to stationary capillary waves. Finally, the flow exhibits a complex three-dimensional converging pattern immediately below the obstacle.